ATTACHMENT 2

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WATER RESOURCES STUDY

PURCELLVILLE, VIRGINIA

MARCH 14, 2000

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Because of the favorable groundwater conditions and the ability to develop new groundwater supplies over a large mostly rural area with relatively low infrastructure costs, we believe that it will be feasible to develop 15% to 25% of the total estimated groundwater recharge (5 mgd). This would be equivalent to a total sustainable yield of approximately 750,000 to 1,250,000 gallons per day from groundwater sources. This estimate may be low in that it does not account for increased aquifer recharge due to downward leakage from the water table aquifer and inflow from areas outside of the study area. However, this estimate does not account for periods of long term drought such as was experienced in Loudoun County last summer. Using a drought recharge rate of 6 inches per year (Memorandum from Jeffrey Widmeyer, LCDH dated February 27, 1989), under worst-case conditions the estimated sustainable yield would be 450,000 to 750,000 gallons per day. This range probably should be used for planning purposes by the town in determining the overall feasibility of developing groundwater as a public water supply.

Ultimately, the amount of groundwater available for development will depend on successfully locating high yielding wells and demonstrating sustainable capacity through long term aquifer testing and monitoring of potential impacts to existing groundwater users and surface water bodies. Potential drawdown impacts to existing groundwater users should be minimal due to the relatively rural setting found throughout much of the study area. Potential impact to stream baseflow should not be significant during non-drought conditions since the potential reductions in baseflow from groundwater pumping would likely represent less than 7 percent of the total mean flow in Catoctin Creek (based on capturing 15% of available groundwater recharge and that groundwater represents an estimated 43% of total stream flow). During severe drought conditions groundwater pumpage could have a more significant impact on stream baseflow.

D. Recommended Groundwater Exploration Areas

The study area was subdivided into six general areas where additional groundwater exploration and possible resource development were considered. The first four potential groundwater exploration areas are considered favorable to groundwater development due to the presence of several of the hydrogeologic factors that are known to have a positive influence on the development of high-yielding water supply wells, while minimizing potential water quality concerns relevant to the study area and potential impacts to existing groundwater users. The last two are not considered feasible for the development of groundwater resources due to water quality concerns and the greater likelihood of impacting existing wells. They are reviewed in this discussion as a matter of completeness and for comparison with recommended areas.

The groundwater exploration areas were ranked on the basis of hydrogeologic factors, potential water quality concerns (sources of pollution), potential impact to nearby wells, proximity to infrastructure and property access/ownership considerations. A matrix summary of these considerations and a ranking of recommended groundwater explorations areas from most favorable to least favorable is presented in Table 5-2. Figure 5-7 illustrates the general location of the recommended groundwater exploration areas (GWEA's 1 through 4). The advantages and disadvantages of each groundwater exploration area are discussed below.

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1. **Short Hill Mountain** - This area is located at the base of Short Hill Mountain near the water treatment plant and along portions of the finished water line. This area is considered the most favorable hydrogeologically with wells targeting fracture-correlated lineaments and the Short Hill fault at depth. Well yields in the range of 100 to 250 gpm can be expected based on existing well records. The area is rural with few groundwater users and no known contamination sources. Water supplies could be pumped directly into the raw or finished water lines depending on treatment requirements. Property access is considered moderate due to potential future growth pressures.

2. **Purcellville's Hirst Reservoir** - This area is not as favorable hydrogeologically but the land is owned by the town, undeveloped and well protected. Operational considerations are considered poor to moderate due to the distance from the treatment plant. Property access is considered good due to ownership. Groundwater recharge estimates for this watershed are nearly 1 mgd, a portion of which discharges to the springs and the reservoir. Wells would serve to capture and develop a larger proportion of the available groundwater resources in this area. The wells would provide a raw water source to the treatment plant. Separate treatment facilities would not be required at the well site(s).

3. **Reservoir to WTP** - The area along the raw water line between the Hirst Reservoir and Purcellville's water treatment plant should also be considered. The potential well yield in this area is considered to be moderately good. The area is rural with few groundwater users, no known contamination sources and relatively slow growth pressure. Wells would be developed near the existing water line providing additional raw water supplies to the treatment plant. Expansion of the treatment plant may be required to accommodate the additional raw water sources or a finished water line may be needed to convey treated groundwater sources to the finished water transmission line.

4. **Northern UGA** - The northern section of the Urban Growth Area is considered favorable hydrogeologically and is believed to be a sufficient distance from known contamination sources located within the town limits. Additional protection may be provided by Catoctin Creek, which may act as a groundwater divide, potentially preventing groundwater movement to the north. Operationally, the wells would be relatively close to town and would be connected directly into finished water lines. However, at this point there is no infrastructure in this area. Property access is considered poor due to the relatively strong future growth potential in this area which may make it difficult to obtain access agreements.

5. **Southern UGA** - The southern section of the Urban Growth Area is considered favorable hydrogeologically but poor to moderate due to potential water quality concerns and potential impact to existing groundwater users

6. **Town Limits** - Groundwater development within the town limits is considered to be poor due to groundwater contamination, potential interference with existing town wells and access to available property. Operationally, this area is considered to be good due to proximity to existing infrastructure. However, overall, additional groundwater development within the town limits or in the southern UGA should not be considered due to water quality concerns and potential drawdown impacts to residential developments south and southwest of the town limits and with the Town of Hamilton's wells to the east. Furthermore, Purcellville's undeveloped Main Street well should not be developed and the town's existing Main Street wells should be phased out of operation over time as new water sources are developed due to high operational costs of these wells.

Each recommended area has multiple potential test well sites. The location and ranking of specific test well sites should be based on further site-specific investigations including detailed geologic mapping and surface geophysical investigation to confirm and more accurately locate water-bearing fracture zones in the subsurface, delineation of wellhead protection areas and identification of potential contaminant sources, and an exploratory test well drilling program.

E. Costs of Development

A budgetary cost estimate has been prepared for the siting and installation of groundwater supply wells and designing and building the associated infrastructure to treat and/or interconnect the water sources. In general, costs include initial field investigations and exploratory test well drilling; construction, testing and permitting of production wells; design and construction of pump house with chlorination and iron/manganese treatment facilities; and design and construction of water supply lines and interconnections. Property acquisition costs are also included, although these cost are highly uncertain.

Cost estimates are based upon an assumption of drilling of a total of 15 test wells; 8 production wells with a capacity of 65 gpm each, at an average distance of 400 feet from exiting lines; and 4 well houses. Based on these assumptions a development cost of approximately one million dollars can be anticipated. Such development would be anticipated to produce approximately 0.42 MGD based on 13.3 hours per day of operation. *Note, as cost figures are reviewed, some refinement of cost estimates may occur before final report is submitted.*

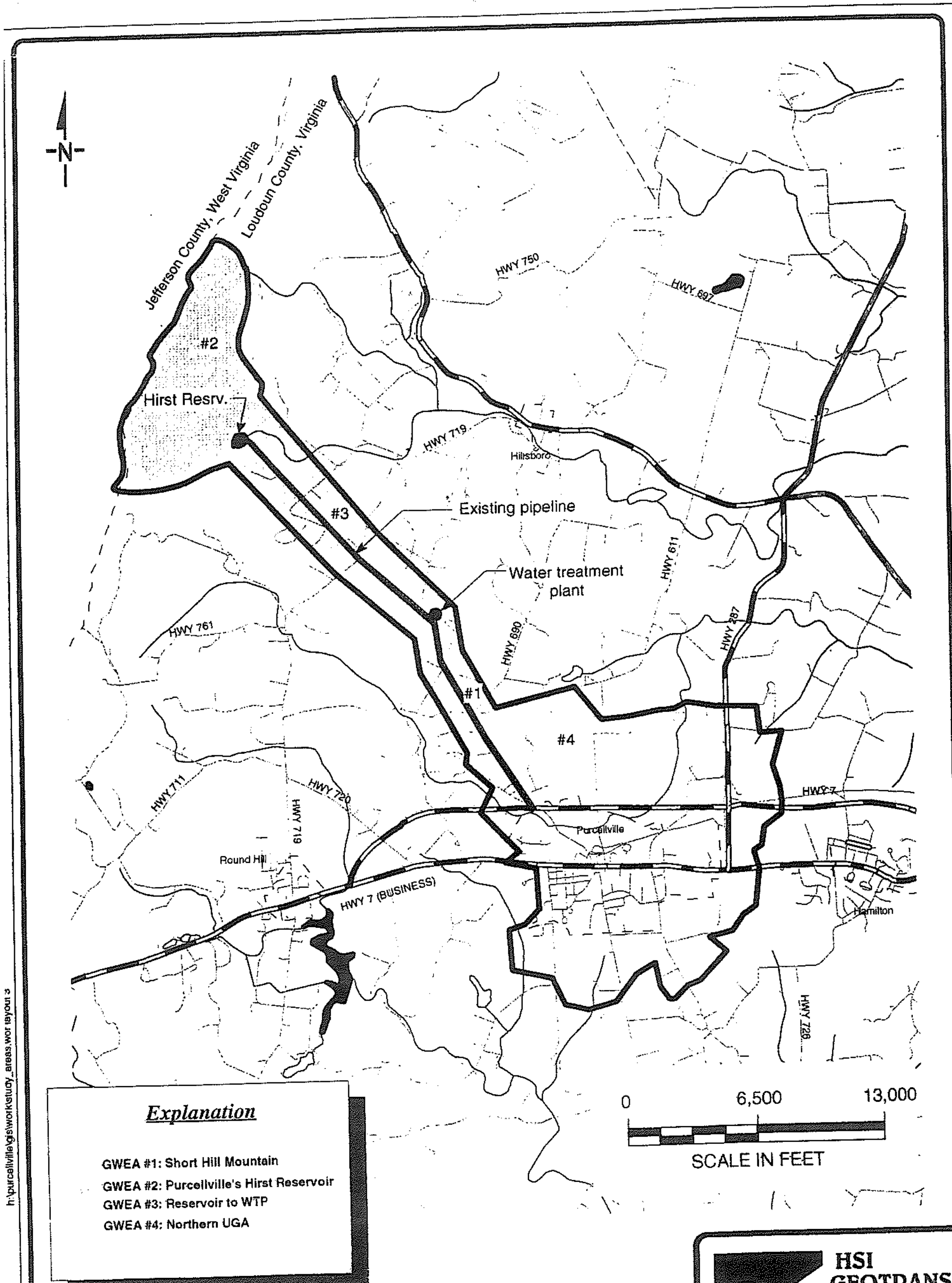

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Figure 5-7. Recommended exploration areas

Table 5-2
Groundwater Exploration Area Evaluation Matrix
Town of Purcellville Water Resources Study

Potential Groundwater Exploration Area	Potential Well Yield (Weight 4)	Potential Water Quality Concerns (Weight 4)	Potential Impact to Area Groundwater Users (Weight 3)	Operational Considerations (Weight 2)	Property Access (Weight 2)	Total	Ranking
Short Hill Mountain	3	3	2	3	2	40	1
Reservoir	1	3	3	2	3	35	3
Reservoir to WTP	2	3	3	2	2	37	2
Northern UGA	2	2	2	2	1	28	4
Southern UGA	2	2	1	2	1	25	5
In Town	2	1	1	3	1	23	6

Rating
3 - Good
2 - Intermediate
1 - Poor

Weighting Factors
4 - most important component
3 -
2 -
1 - least important component

Potential Well Yield - Poor (<50 gpm), Intermediate (50-100 gpm), Good (100-250 gpm)
Potential Water Quality Concerns - Poor (nearby contaminant sources), Intermediate (sources far away), Good (no known sources)
Potential Impact to Groundwater Users - Poor (nearby wells or high density), Intermediate (wells farther away or low density), Good (no wells or very low density)
Operational Considerations - includes distance to wells, proximity to existing infrastructure, source used as finished or raw water, safety
Property Access - Poor (area developed or has potential of being developed), Intermediate (area not developed), Good (existing property)

F. Conclusions

HSI GeoTrans has completed a preliminary evaluation on the feasibility of developing groundwater resources to meet or supplement future water supply needs for the Town of Purcellville in western Loudoun County, Virginia. The primary objective of this portion of the study was to assess the overall availability of groundwater resources within the study area. A secondary objective was to identify favorable areas where additional groundwater exploration should occur. The conclusions reached from this investigation are as follows:

1. The overall potential of developing additional groundwater resources for the Town of Purcellville is believed to be excellent due to favorable hydrogeologic conditions and the large mostly rural area where groundwater resources may be developed with minimal additional infrastructure.

2. A total of approximately 200 photolineaments and 68 DEM lineaments were identified within the study area through remote sensing analysis. The dominant lineament trends correlate well with tectonic bedrock fabric orientations strongly suggesting that most mapped lineaments represent true manifestations of underlying bedrock fracture zones.

3. An inventory of water supply wells indicates that relatively large well yields in excess of 100 gpm are possible within the study area. The reported highest yielding well in the area is rated at 250 gpm and is located within the study area near Purcellville's finished water transmission line.

4. The estimated groundwater recharge potential for the study area is approximately 5 million gallons per day assuming an average recharge rate of 10 in/yr and 3 million gallons per day assuming a drought recharge rate of 6 in/yr. Based on worst-case drought recharge estimates, it is believed that 450,000 to 750,000 gallons per day could be developed by the Town of Purcellville without significant impact to area groundwater users or surface water flow.

5. Four potential groundwater exploration areas have been identified. These areas have been selected due to the presence of favorable conditions for developing high-yield water supply wells, low contaminant threat and low potential impact on existing groundwater users. Each recommended area has multiple potential test well sites. The location and ranking of specific test well sites should be based on further site-specific investigations including a surface geophysical investigation and site accessibility.

G. Recommendations

The overall potential of developing groundwater supplies to meet or to supplement Purcellville's future water supply needs is excellent. It is estimated that up to eight production well facilities will be needed to provide up to 0.42 MGD of system capacity. This is based on the assumption that each production well facility would have an average yield of approximately 65 gpm. This is considered reasonable for the study area. It is assumed that each well facility would be pumped up to 13 hours per day based on current VDH regulations. To help insure the successful development of groundwater resources it will be necessary to conduct more detailed hydrogeologic studies within each of the recommended groundwater exploration areas. These studies should include the following recommended phases:

1. Conduct detailed geologic mapping to refine and/or verify geologic contacts, analyze geologic structures such as folds, faults and bedrock fracture sets, and to confirm

mapped lineament locations and origin. Geologic cross sections will be constructed to show the orientation and depth of favorable hydrogeologic features such as faults or formation contacts.

2. Identify specific properties that are favorable for developing groundwater resources. This will be accomplished by generating electronic overlay maps of bedrock geology, mapped lineaments, surface water features, topography, soils, well yield, water quality and potential contaminant sources (depending on data availability) onto digital tax maps. This will provide a graphical means to evaluate the data and help to discern specific trends in well yields and water quality. Specific groundwater exploration areas will be selected and the owners of the properties will be identified.

3. Conduct surface geophysical surveys to confirm the presence or absence of a water-filled fracture zones and to precisely locate the orientation and dip of these fracture zones at depth. Based on the results of the geophysical studies, specific exploratory drilling sites will be identified and ranked.

4. Prepare specifications and solicit bids from qualified well drillers. The selected driller will then drill exploratory test wells and the yield and water quality will be assessed at each site. Selected test wells will be developed into public community water supply production wells.

5. Develop a source water protection plan for each new groundwater source.

6. Develop a groundwater level and streamflow monitoring program to monitor the long-term affects of the groundwater withdrawal.